CHAPTER 6 (Odd)

1. a. 2, 3, 4 in parallel b. 2, 3 in parallel c. 2, 3 in series, 1, 4 in parallel

3. a. $R_T = 9\ \Omega \parallel 18\ \Omega = \dfrac{9 \cdot 18}{9 + 18} = \dfrac{162}{27} = \mathbf{6\ \Omega}$

$G_T = \dfrac{1}{R_T} = \dfrac{1}{6\ \Omega} = \mathbf{0.1667\ S}$

b. $G_T = \dfrac{1}{3\ k\Omega} + \dfrac{1}{2\ k\Omega} + \dfrac{1}{6\ k\Omega} = 0.333\ mS + 0.5\ mS + 0.167\ mS = \mathbf{1\ mS}$

$R_T = \dfrac{1}{G_T} = \dfrac{1}{1\ mS} = \mathbf{1\ k\Omega}$

or $6\ k\Omega \parallel 3\ k\Omega = 2\ k\Omega$, $2\ k\Omega \parallel 2\ k\Omega = \mathbf{1\ k\Omega}$

c. $R_T = 3.3\ k\Omega \parallel 5.6\ k\Omega = \dfrac{(3.3\ k\Omega)(5.6\ k\Omega)}{3.3\ k\Omega + 5.6\ k\Omega} = \mathbf{2.076\ k\Omega}$

$G_T = \dfrac{1}{R_T} = \dfrac{1}{2.076\ k\Omega} = \mathbf{0.4817\ mS}$

d. $4\ \Omega \parallel 4\ \Omega = 2\ \Omega$, $8\ \Omega \parallel 8\ \Omega = 4\ \Omega$

$R_T = 2\ \Omega \parallel 4\ \Omega = \dfrac{(2\ \Omega)(4\ \Omega)}{2\ \Omega + 4\ \Omega} = \mathbf{1.333\ \Omega}$

$G_T = \dfrac{1}{R_T} = \dfrac{1}{1.333\ \Omega} = \mathbf{0.75\ S}$

e. $G_T = \dfrac{1}{10\ \Omega} + \dfrac{1}{2\ k\Omega} + \dfrac{1}{40\ k\Omega} = 0.1\ S + 0.5\ mS + 0.025\ mS = \mathbf{100.525\ mS}$

$R_T = \dfrac{1}{G_T} = \dfrac{1}{100.525\ mS} = \mathbf{9.948\ \Omega}$

f. $R'_T = \dfrac{9.1\ \Omega}{3} = 3.033\ \Omega$, $R''_T = \dfrac{2.2\ \Omega}{2} = 1.1\ \Omega$

$G_T = \dfrac{1}{3.033\ \Omega} + \dfrac{1}{1.1\ \Omega} + \dfrac{1}{4.7\ \Omega} = 0.3297\ S + 0.9091\ S + 0.2128\ S = \mathbf{1.4516\ S}$

$R_T = \dfrac{1}{G_T} = \dfrac{1}{1.4516\ S} = \mathbf{0.6889\ \Omega}$

5. a. $G_T = NG_1 + G_2$

$\dfrac{1}{6\ \Omega} = 2\left[\dfrac{1}{18\ \Omega}\right] + \dfrac{1}{R} \Rightarrow R = \mathbf{18\ \Omega}$

b. $G_T = NG_1 + G_2 + G_3$

$\dfrac{1}{4\ \Omega} = 2\left[\dfrac{1}{R_1}\right] + \dfrac{1}{9\ \Omega} + \dfrac{1}{18\ \Omega}$

$0.25\ S = \dfrac{2}{R_1} = 0.111\ S + 0.0556\ S$

$R_1 = \mathbf{24\ \Omega} = R_2$

7. $24\ \Omega \parallel 24\ \Omega = 12\ \Omega$

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{12\ \Omega} + \frac{1}{120\ \Omega}$$

$$0.1\ \text{S} = \frac{1}{R_1} + 0.08333\ \text{S} + 0.00833\ \text{S}$$

$$0.1\ \text{S} = \frac{1}{R_1} + 0.09167\ \text{S}$$

$$\frac{1}{R_1} = 0.1\ \text{S} - 0.09167\ \text{S} = 0.00833\ \text{S}$$

$$R_1 = \frac{1}{0.00833\ \text{S}} = \mathbf{120\ \Omega}$$

9. a. $G_T = \frac{1}{3\ \Omega} + \frac{1}{6\ \Omega} + \frac{1}{1.5\ \Omega} = 0.333\ \text{S} + 0.167\ \text{S} + 0.667\ \text{S} = \mathbf{1.167\ S}$

$R_T = \frac{1}{G_T} = \frac{1}{1.167\ \text{S}} = \mathbf{0.857\ \Omega}$

b. $I_s = EG_T = \frac{E}{R_T} = \frac{0.9\ \text{V}}{0.857\ \Omega} = \mathbf{1.05\ A}$

$I_1 = \frac{E}{R_1} = \frac{0.9\ \text{V}}{3\ \Omega} = \mathbf{0.3\ A}$

$I_2 = \frac{E}{R_2} = \frac{0.9\ \text{V}}{6\ \Omega} = \mathbf{0.15\ A}$

$I_3 = \frac{E}{R_3} = \frac{0.9\ \text{V}}{1.5\ \Omega} = \mathbf{0.6\ A}$

c. $I_s \stackrel{?}{=} I_1 + I_2 + I_3$

$1.05\ \text{A} = 0.3\ \text{A} + 0.15\ \text{A} + 0.6\ \text{A}$

$1.05\ \text{A} \stackrel{\checkmark}{=} 1.05\ \text{A}$

d. R_1: $P_1 = I_1^2R_1 = (0.3\ \text{A})^2\ 3\ \Omega = \mathbf{0.27\ W}$

R_2: $P_2 = I_2^2R_2 = (0.15\ \text{A})^2\ 6\ \Omega = \mathbf{0.135\ W}$

R_3: $P_3 = I_3^2R_3 = (0.6\ \text{A})^2\ 1.5\ \Omega = \mathbf{0.54\ W}$

$P_{del} = EI_s = (0.9\ \text{V})(1.05\ \text{A}) = \mathbf{0.945\ W}$

$P_{del} \stackrel{?}{=} P_1 + P_2 + P_3$

$0.945\ \text{W} = 0.27\ \text{W} + 0.135\ \text{W} + 0.54\ \text{W}$

$0.945\ \text{W} \stackrel{\checkmark}{=} 0.945\ \text{W}$

e. $R_1, R_2 \Rightarrow 1/2\ \text{W}$, $R_3 \Rightarrow 1\ \text{W}$

11. a. $I = \frac{E}{R} = \frac{120\ \text{V}}{1.8\ \text{k}\Omega} = \mathbf{66.67\ mA}$

b. $R_T = \frac{R}{N} = \frac{1.8\ \text{k}\Omega}{8} = \mathbf{225\ \Omega}$

c. $P = EI = (120\ \text{V})(66.67\ \text{mA}) = \mathbf{8\ W}$

d. No effect!

13. a. $R_T = 20\ \Omega \parallel 5\ \Omega = 4\ \Omega$

$I_s = \frac{E}{R_T} = \frac{30\ \text{V}}{4\ \Omega} = \mathbf{7.5\ A}$

CDR: $I_1 = \frac{5\ \Omega\ I_s}{5\ \Omega + 20\ \Omega} = \frac{1}{5}(7.5\ \text{A}) = \mathbf{1.5\ A}$

b. $10\ k\Omega \parallel 10\ k\Omega = 5\ k\Omega$

$R_T = 1\ k\Omega \parallel 5\ k\Omega = 0.833\ k\Omega$

$I_s = \dfrac{E}{R_T} = \dfrac{8\ V}{0.833\ k\Omega} = \mathbf{9.6\ mA}$

$R'_T = 10\ k\Omega \parallel 1\ k\Omega = 0.9091\ k\Omega$

$I_1 = \dfrac{R'_T I_s}{R'_T + 10\ k\Omega} = \dfrac{(0.9091\ k\Omega)(9.6\ mA)}{0.9091\ k\Omega + 10\ k\Omega} = \dfrac{8.727\ mA}{10.9091} = \mathbf{0.8\ mA}$

15. $\dfrac{1}{R_T} = \dfrac{1}{5\ \Omega} + \dfrac{1}{10\ \Omega} + \dfrac{1}{20\ \Omega} = 0.2\ S + 0.1\ S + 0.05\ S = 0.35\ S$

$R_T = \dfrac{1}{0.35\ S} = 2.857\ \Omega$

$P_{del} = \dfrac{E^2}{R_T} = \dfrac{(60\ V)^2}{2.857\ \Omega} = \mathbf{1260\ W}$

17. a. $I = \dfrac{24\ V - 8\ V}{4\ k\Omega} = \dfrac{16\ V}{4\ k\Omega} = \mathbf{4\ mA}$

b. $V = \mathbf{24\ V}$

c. $I_s = \dfrac{24\ V}{10\ k\Omega} + 4\ mA + \dfrac{24\ V}{2\ k\Omega} = 2.4\ mA + 4\ mA + 12\ mA = \mathbf{18.4\ mA}$

19. a. $I_1 = 8\ mA - 5\ mA = \mathbf{3\ mA}$

$I_2 = 5\ mA - 4\ mA = \mathbf{1\ mA}$

$I_3 = I_1 - 1.5\ mA = 3\ mA - 1.5\ mA = \mathbf{1.5\ mA}$

b. $I_2 = 6\ \mu A - 2\ \mu A = \mathbf{4\ \mu A}$

$I_3 = 2\ \mu A - 0.5\ \mu A = \mathbf{1.5\ \mu A}$

$I_4 = I_2 + I_3 = 4\ \mu A + 1.5\ \mu A = \mathbf{5.5\ \mu A}$

$I_1 = I_4 + 0.5\ \mu A = 5.5\ \mu A + 0.5\ \mu A = \mathbf{6\ \mu A}$

21. a. $R_1 = \dfrac{E}{I_1} = \dfrac{10\ V}{2\ A} = \mathbf{5\ \Omega}$

$I_2 = I - I_1 = 3\ A - 2\ A = 1\ A$

$R_2 = \dfrac{E}{I_2} = \dfrac{10\ V}{1\ A} = \mathbf{10\ \Omega}$

b. $E = I_1R_1 = (2\ A)(6\ \Omega) = \mathbf{12\ V}$

$I_2 = \dfrac{E}{R_2} = \dfrac{12\ V}{9\ \Omega} = \mathbf{1.333\ A}$

$I_3 = \dfrac{P}{V} = \dfrac{12\ W}{12\ V} = \mathbf{1\ A}$

$R_3 = \dfrac{E}{I_3} = \dfrac{12\ V}{1\ A} = \mathbf{12\ \Omega}$

$I = I_1 + I_2 + I_3 = 2\ A + 1.333\ A + 1\ A = \mathbf{4.333\ A}$

c. $I_1 = \frac{64\text{ V}}{1\text{ k}\Omega} = \mathbf{64\text{ mA}}$

$I_3 = \frac{64\text{ V}}{4\text{ k}\Omega} = \mathbf{16\text{ mA}}$

$I_3 = I_1 + I_2 + I_3$

$I_2 = I_s - I_1 - I_3 = 100\text{ mA} - 64\text{ mA} - 16\text{ mA} = 20\text{ mA}$

$R = \frac{E}{I_2} = \frac{64\text{ V}}{20\text{ mA}} = \mathbf{3.2\text{ k}\Omega}$

$I = I_2 + I_3 = 20\text{ mA} + 16\text{ mA} = \mathbf{36\text{ mA}}$

d. $P = \frac{V_1^2}{R_1} \Rightarrow V_1 = \sqrt{PR_1} = \sqrt{(30\text{ W})(30\ \Omega)} = \mathbf{30\text{ V}}$

$E = V_1 = \mathbf{30\text{ V}}$

$I_1 = \frac{E}{R_1} = \frac{30\text{ V}}{30\ \Omega} = \mathbf{1\text{ A}}$

$I_3 = I_2, \qquad I_s = I_1 + I_2 + I_3 = I_1 + 2I_2$

$2\text{ A} = 1\text{ A} + 2I_2$

$I_2 = \frac{1}{2}(1\text{ A}) = 0.5\text{ A}$

$I_3 = \mathbf{0.5\text{ A}}$

$R_2 = R_3 = \frac{E}{I_2} = \frac{30\text{ V}}{0.5\text{ A}} = \mathbf{60\ \Omega}$

$P_{R_2} = I_2^2 R_2 = (0.5\text{ A})^2 \cdot 60\ \Omega = \mathbf{15\text{ W}}$

23. a. $I_1 = \frac{3\ \Omega(12\text{ A})}{3\ \Omega + 6\ \Omega} = \mathbf{4\text{ A}}, I_2 = \frac{6\ \Omega(12\text{ A})}{3\ \Omega + 6\ \Omega} = \mathbf{8\text{ A}}$

b. $\frac{8\ \Omega}{2} = 4\ \Omega, \frac{6\ \Omega}{3} = 2\ \Omega$

$I_1 = \frac{2\ \Omega(6\text{ A})}{2\ \Omega + 4\ \Omega} = \mathbf{2\text{ A}}, I_2 = \frac{4\ \Omega(6\text{ A})}{4\ \Omega + 2\ \Omega} = \mathbf{4\text{ A}}$

$I_3 = \frac{I_1}{2} = \frac{2\text{ A}}{2} = \mathbf{1\text{ A}}$

$I_4 = \frac{I_2}{3} = \frac{4\text{ A}}{3} = \mathbf{1.333\text{ A}}$

c. $2\ \Omega \parallel 3\ \Omega = \frac{6}{5}\ \Omega, I_1 = \frac{6/5\ \Omega(500\text{ mA})}{6/5\ \Omega + 1\ \Omega} = \mathbf{272.73\text{ mA}}$

$I_2 = \frac{1\ \Omega(500\text{ mA})}{1\ \Omega + 6/5\ \Omega} = \mathbf{227.27\text{ mA}}$

$I_3 = \frac{2\ \Omega(I_2)}{2\ \Omega + 3\ \Omega} = \frac{2\ \Omega(227.27\text{ mA})}{5\ \Omega} = \mathbf{90.91\text{ mA}}$

$I_4 = \mathbf{500\text{ mA}}$

d. $V_{18\Omega} = I_1 R = (4\text{ A})(18\ \Omega) = 72\text{ V}$

$$I_2 = \frac{V}{R_T} = \frac{72\text{ V}}{4\ \Omega + 12\ \Omega} = \frac{72\text{ V}}{16\ \Omega} = \mathbf{4.5\text{ A}}$$

$I_3 = I_1 + I_2 = 4\text{ A} + 4.5\text{ A} = \mathbf{8.5\text{ A}}$

$I_s = I_3 = \mathbf{8.5\text{ A}}$

25. a. CDR: $I_{6\Omega} = \dfrac{2\ \Omega\, I}{2\ \Omega + 6\ \Omega} = 1\text{A}$

$$I = \frac{1\text{ A}(8\ \Omega)}{2\ \Omega} = \mathbf{4\text{ A}} = I_2$$

$I_1 = I - 1\text{ A} = \mathbf{3\text{ A}}$

b. KCL: $I_3 = I = \mathbf{6\ \mu A}$

By inspection: $I_2 = \mathbf{2\ \mu A}$

$I_1 = I - 2(2\ \mu\text{A}) = 6\ \mu\text{A} - 4\ \mu\text{A} = \mathbf{2\ \mu A}$

Since all currents are equal

$R = \mathbf{9\ \Omega}$

27. $68\text{ mA} = I_1 + I_2 + I_3 = I_1 + 4\,I_1 + 3I_2$

$68\text{ mA} = I_1 + 4\,I_1 + 3(4\,I_1)$

$68\text{ mA} = I_1 + 4\,I_1 + 12\,I_1$

$68\text{ mA} = 17\,I_1$

$$I_1 = \frac{68\text{ mA}}{17} = 4\text{ mA}$$

$I_2 = 4\,I_1 = 16\text{ mA}$

$I_3 = 3\,I_2 = 48\text{ mA}$

$$R_1 = \frac{V_{R_1}}{I_1} = \frac{E}{I_1} = \frac{24\text{ V}}{4\text{ mA}} = \mathbf{6\text{ k}\Omega}$$

$$R_2 = \frac{E}{I_2} = \frac{24\text{ V}}{16\text{ mA}} = \mathbf{1.5\text{ k}\Omega}$$

$$R_3 = \frac{E}{I_3} = \frac{24\text{ V}}{48\text{ mA}} = \mathbf{0.5\text{ k}\Omega}$$

29. $I_{8\Omega} = \dfrac{16\text{ V}}{8\ \Omega} = 2\text{ A}$

$I = 5\text{ A} - 2\text{ A} = \mathbf{3\text{ A}}$

$I_R = 5\text{ A} + I = 5\text{ A} + 3\text{ A} = 8\text{ A}$

$$R = \frac{V_R}{I_R} = \frac{16\text{ V}}{8\text{ A}} = \mathbf{2\ \Omega}$$

31. a. $V_L = \dfrac{4.7\text{ k}\Omega(9\text{ V})}{4.7\text{ k}\Omega + 2.2\text{ k}\Omega} = \dfrac{42.3\text{ V}}{6.9} = \mathbf{6.13\text{ V}}$

b. $V_L = E = \mathbf{9\text{ V}}$

c. $V_L = E = \mathbf{9\text{ V}}$

33. a. $V_2 = \dfrac{20\text{ k}\Omega(6\text{ V})}{20\text{ k}\Omega + 10\text{ k}\Omega} = \dfrac{120\text{ V}}{30} = \mathbf{4\text{ V}}$

b. $20\text{ k}\Omega \parallel 11\text{ M}\Omega = 19.96\text{ k}\Omega$

$$V_2 = \frac{19.96\text{ k}\Omega(6\text{ V})}{19.96\text{ k}\Omega + 10\text{ k}\Omega} = \frac{119.76\text{ V}}{29.96} = \mathbf{3.997\text{ V}}$$

c. $R_m = (10\text{ V})(20{,}000\ \Omega/\text{V}) = 200\text{ k}\Omega$

$20\text{ k}\Omega \parallel 200\text{ k}\Omega = 18.18\text{ k}\Omega$

$$V_2 = \frac{18.18\text{ k}\Omega(6\text{ V})}{18.18\text{ k}\Omega + 10\text{ k}\Omega} = \mathbf{3.871\text{ V}}$$

(b) more accurate than (c) but both readings in the "neighborhood."

d. $R_2 \parallel R_m = 200\text{ k}\Omega \parallel 200\text{ k}\Omega = 100\text{ k}\Omega$

$$V_2 = \frac{(100\text{ k}\Omega)(6\text{ V})}{100\text{ k}\Omega + 100\text{ k}\Omega} = \mathbf{3\text{ V}}$$

e. R_m as large as possible (compared to load).

35. $V_a = 8.8$ V is an incorrect reading.

$$V_{1\text{k}\Omega} = \frac{1\text{ k}\Omega(12\text{ V} - 4\text{ V})}{1\text{ k}\Omega + 4\text{ k}\Omega} = \frac{1}{5}(8\text{ V}) = 1.6\text{ V}$$

$V_a = 12\text{ V} - 1.6\text{ V} = 10.4\text{ V}$

4 V supply reversed!

$$V_{1\text{k}\Omega} = \frac{1\text{ k}\Omega(12\text{ V} + 4\text{ V})}{1\text{ k}\Omega + 4\text{ k}\Omega} = \frac{1}{5}(16\text{ V}) = 3.2\text{ V}$$

$V_a = 12\text{ V} - 3.2\text{ V} = 8.8\text{ V}$ as indicated

CHAPTER 6 (Even)

2. a. There are no single elements in parallel.

   b. R_6 & R_7, R_1 & R_3 and E are in series.

   c. $R_5 \parallel (R_6 + R_7), R_2 \parallel (R_1 + E + R_3)$

4. a. $$G_T = 0.55\text{ S} = \frac{1}{4\ \Omega} + \frac{1}{R} + \frac{1}{6\ \Omega}$$

$$0.55\text{ S} = 0.25\text{ S} + \frac{1}{R} + 0.1667\text{ S}$$

$$0.1333\text{ S} = \frac{1}{R}$$

$$R = \frac{1}{0.1333\text{ S}} = \mathbf{7.5\ \Omega}$$

   b. $$G_T = 0.45\text{ mS} = \frac{1}{5\text{ k}\Omega} + \frac{1}{8\text{ k}\Omega} + \frac{1}{R}$$

$$0.45\text{ mS} = 0.2\text{ mS} + 0.125\text{ mS} + \frac{1}{R}$$

$$R = \frac{1}{0.125\text{ mS}} = \mathbf{8\text{ k}\Omega}$$

6. $$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$\frac{1}{20\ \Omega} = \frac{1}{R_1} + \frac{1}{5R_1} + \frac{1}{\frac{R_1}{2}} = 1\left[\frac{1}{R_1}\right] + \frac{1}{5}\left[\frac{1}{R_1}\right] + 2\left[\frac{1}{R_1}\right] = 3.2\left[\frac{1}{R_1}\right]$$

and $R_1 = 3.2(20\ \Omega) = \mathbf{64\ \Omega}$

$R_2 = 5R_1 = 5(64\ \Omega) = \mathbf{320\ \Omega}$

$R_3 = \frac{1}{2}R_1 = \frac{64\ \Omega}{2} = \mathbf{32\ \Omega}$

8. a. $R_T = 8\text{ k}\Omega \parallel 24\text{ k}\Omega = \mathbf{6\text{ k}\Omega}$

$$G_T = \frac{1}{R_T} = \frac{1}{6\text{ k}\Omega} = \mathbf{0.167\text{ mS}}$$

   b. $$I_s = \frac{E}{R_T} = \frac{48\text{ V}}{6\text{ k}\Omega} = \mathbf{8\text{ mA}}$$

$$I_1 = \frac{48\text{ V}}{8\text{ k}\Omega} = \mathbf{6\text{ mA}}$$

$$I_2 = \frac{48\text{ V}}{24\text{ k}\Omega} = \mathbf{2\text{ mA}}$$

   c. $I_s = I_1 + I_2$

$8\text{ mA} = 6\text{ mA} + 2\text{ mA}$

$8\text{ mA} \stackrel{\checkmark}{=} 8\text{ mA}$

d. $P_1 = I_1^2R_1 = (6\text{ mA})^2\ 8\text{ k}\Omega = (36 \times 10^{-6})(8 \times 10^3) = \mathbf{0.288\ W}$

$P_2 = I_2^2R_2 = (2\text{ mA})^2\ 24\text{ k}\Omega = (4 \times 10^{-6})(24 \times 10^3) = \mathbf{96\ mW}$

$P_{del} = EI_s = (48\text{ V})(8\text{ mA}) = \mathbf{384\ mW}$

$P_{del} \stackrel{?}{=} P_1 + P_2$

$384\text{ mW} = 288\text{ mW} + 96\text{ mW}$

$384\text{ mW} \stackrel{\checkmark}{=} 384\text{ mW}$

e. both 1/2 W

10. a. $G_T = \dfrac{1}{R_1} + \dfrac{1}{R_2} + \dfrac{1}{R_3} = \dfrac{1}{2.2\text{ k}\Omega} + \dfrac{1}{4.7\text{ k}\Omega} + \dfrac{1}{6.8\text{ k}\Omega}$

$= 0.4545\text{ mS} + 0.2128\text{ mS} + 0.1471\text{ mS} = \mathbf{0.8144\ mS}$

$R_T = \dfrac{1}{G_T} = \dfrac{1}{0.8144\text{ mS}} = \mathbf{1.2279\ k\Omega}$

b. $I_s = \dfrac{E}{R_T} = \dfrac{12\text{ V}}{1.2279\text{ k}\Omega} = \mathbf{9.7728\ mA}$

$I_1 = \dfrac{E}{R_1} = \dfrac{12\text{ V}}{2.2\text{ k}\Omega} = \mathbf{5.4545\ mA}$

$I_2 = \dfrac{E}{R_2} = \dfrac{12\text{ V}}{4.7\text{ k}\Omega} = \mathbf{2.5532\ mA}$

$I_3 = \dfrac{E}{R_3} = \dfrac{12\text{ V}}{6.8\text{ k}\Omega} = \mathbf{1.7647\ mA}$

c. $I_s = I_1 + I_2 + I_3$

$9.7728\text{ mA} = 5.4545\text{ mA} + 2.5532\text{ mA} + 1.7647\text{ mA}$

$9.7728\text{ mA} \stackrel{\checkmark}{=} 9.7724\text{ mA}$

d. $P_1 = I_1^2R_1 = (5.4545\text{ mA})^2\ 2.2\text{ k}\Omega = \mathbf{65\ mW}$

$P_2 = I_2^2R_2 = (2.5532\text{ mA})^2\ 4.7\text{ k}\Omega = \mathbf{31\ mW}$

$P_3 = I_3^2R_3 = (1.7647\text{ mA})^2\ 6.8\text{ k}\Omega = \mathbf{21\ mW}$

$P_{del} = EI_s = (12\text{ V})(9.7728\text{ mA}) = \mathbf{117.27\ mW}$

$P_{del} = P_1 + P_2 + P_3$

$117.27\text{ mW} = 65\text{ mW} + 31\text{ mW} + 21\text{ mW}$

$117.27\text{ mW} \stackrel{\checkmark}{=} 117\text{ mW}$

e. all 1/2 W

12. a. Branch 1: $I = \frac{P}{E} = \frac{10(60\text{ W})}{120\text{ V}} = \mathbf{5\text{ A}}$

Branch 2: $I = \frac{P}{E} = \frac{400\text{ W}}{120\text{ V}} = \mathbf{3\frac{1}{3}\text{ A}}$

Branch 3: $I = \frac{P}{E} = \frac{360\text{ W}}{120\text{ V}} = \mathbf{3\text{A}}$

b. $I_s = I_1 + I_2 + I_3 = 5\text{ A} + 3\frac{1}{3}\text{ A} + 3\text{ A} = \mathbf{11\frac{1}{3}\text{ A}}$ **No**

c. $R_T = \frac{E}{I_s} = \frac{120\text{ V}}{11\frac{1}{3}\text{ A}} = \mathbf{10.59\ \Omega}$

d. $P_{del} = EI_s = (120\text{ V})\left[11\frac{1}{3}\text{ A}\right] = \mathbf{1360\text{ W}}$

$P_{del} = P_1 + P_2 + P_3$

$1360\text{ W} = 600\text{ W} + 400\text{ W} + 360\text{ W}$

$1360\text{ W} \overset{\checkmark}{=} 1360\text{ W}$

14. $I_{R_2} = \frac{12\text{ V}}{6\ \Omega} = 2\text{ A},\ I_{R_1} = 6\text{ A} - 2\text{ A} = 4\text{ A}$

$R_1 = \frac{V_{R_1}}{I_{R_1}} = \frac{E}{I_{R_1}} = \frac{12\text{ V}}{4\text{ A}} = \mathbf{3\ \Omega}$

16. a. $8\ \Omega \parallel 12\ \Omega = 4.8\ \Omega,\ 4.8\ \Omega \parallel 4\ \Omega = 2.182\ \Omega$

$I_1 = \frac{24\text{ V} + 8\text{ V}}{2.182\ \Omega} = \mathbf{14.67\text{ A}}$

b. $P_4 = \frac{V^2}{R} = \frac{(24\text{ V} + 8\text{ V})^2}{4\ \Omega} = \mathbf{256\text{ W}}$

c. $I_2 = I_s = \mathbf{14.67\text{ A}}$

18. a. $12\text{ A} + 9\text{ A} + 4\text{ A} - I_1 = 0$

$I_1 = \mathbf{25\text{ A}} \rightarrow$

$I_1 + 4\text{ A} - 6\text{ A} - I_2 = 0$

$I_2 = 25\text{ A} + 4\text{ A} - 6\text{ A} = \mathbf{23\text{ A}} \searrow$

$I_2 - 3\text{ A} - I_3 = 0$

$I_3 = 23\text{ A} - 3\text{ A} = \mathbf{20\text{ A}} \swarrow$

b. $20\text{ A} - 9\text{ A} - I_1 = 0$

$I_1 = \mathbf{11\text{ A}} \rightarrow$

$I_1 - 5\text{ A} - I_2 = 0$

$I_2 = 11\text{ A} - 5\text{ A} = \mathbf{6\text{ A}} \rightarrow$

$I_2 + 8\text{ A} - I_3 = 0$

$I_3 = 6\text{ A} + 8\text{ A} = \mathbf{14\text{ A}} \downarrow$

$I_3 - 4\text{ A} - I_4 = 0$

$I_4 = 14\text{ A} - 4\text{ A} = \mathbf{10\text{ A}} \downarrow$

20. $I_{R_2} = 5\text{ mA} - 2\text{ mA} = 3\text{ mA}$

$E = V_{R_2} = (3\text{ mA})(4\text{ k}\Omega) = \mathbf{12\text{ V}}$

$R_1 = \dfrac{V_{R_1}}{I_{R_1}} = \dfrac{12\text{ V}}{(9\text{ mA} - 5\text{ mA})} = \dfrac{12\text{ V}}{4\text{ mA}} = \mathbf{3\text{ k}\Omega}$

$R_3 = \dfrac{V_{R_3}}{I_{R_3}} = \dfrac{12\text{ V}}{2\text{ mA}} = \mathbf{6\text{ k}\Omega}$

$R_T = \dfrac{E}{I_T} = \dfrac{12\text{ V}}{9\text{ mA}} = \mathbf{1.333\text{ k}\Omega}$

22. $I_2 = \dfrac{4\ \Omega}{12\ \Omega}I_1 = \dfrac{1}{3}I_1 = \mathbf{2\text{ A}}$

$I_3 = \dfrac{4\ \Omega}{2\ \Omega}I_1 = 2I_1 = \mathbf{12\text{ A}}$

$I_4 = \dfrac{4\ \Omega}{40\ \Omega}I_1 = \dfrac{1}{10}I_1 = \mathbf{0.6\text{ A}}$

$I_T = I_1 + I_2 + I_3 + I_4 = 6\text{ A} + 2\text{ A} + 12\text{ A} + 0.6\text{ A} = \mathbf{20.6\text{ A}}$

24. a. $I_1 \cong \dfrac{9}{10}(10\text{ A}) = \mathbf{9\text{ A}}$

b. $I_1/I_2 = 10\ \Omega/1\ \Omega = \mathbf{10}$, $I_3/I_4 = 100\text{ k}\Omega/1\text{ k}\Omega = \mathbf{100}$

c. $I_2/I_3 = 1\text{ k}\Omega/10\text{ k}\Omega = \mathbf{100}$, $I_1/I_4 = 100\text{ k}\Omega/1\ \Omega = \mathbf{100{,}000}$

d. $\dfrac{1}{R_T} = \dfrac{1}{1\ \Omega} + \dfrac{1}{10\ \Omega} + \dfrac{1}{1\text{ k}\Omega} + \dfrac{1}{100\text{ k}\Omega} = 1 + 0.1 + 0.001 + 10 \times 10^{-6}$
$= 1.10101\text{ S}$

$R_T = \dfrac{1}{1.10101\text{ S}} = 0.9083\ \Omega$

$V = IR_T = (10\text{ A})(0.9083\ \Omega) = 9.083\text{ V}$

$I_1 = \dfrac{V}{R_1} = \dfrac{9.083\text{ V}}{1\ \Omega} = \mathbf{9.083\text{ A}}$ vs. 9 A

e. $I_4 = \dfrac{V}{R_4} = \dfrac{9.083\text{ V}}{100\text{ k}\Omega} = 90.83\ \mu\text{A}$

$\dfrac{I_1}{I_4} = \dfrac{9.083\text{ A}}{90.83\ \mu\text{A}} = \mathbf{100{,}000}$ as above

26. $60\text{ mA} = I_1 + I_2 = 3I_2 + I_2 = 4I_2$

and $I_2 = \dfrac{60\text{ mA}}{4} = 15\text{ mA}$

$I_1 = 3I_2 = 3(15\text{ mA}) = 45\text{ mA}$

$V_1 = V_2$

$(45\text{ mA})(2.2\text{ k}\Omega) = (15\text{ mA})(R)$

$R = \dfrac{45\text{ mA}}{15\text{ mA}}(2.2\text{ k}\Omega) = 3(2.2\text{ k}\Omega) = \mathbf{6.6\text{ k}\Omega}$

or $\frac{I_1}{I_2} = \frac{R}{2.2\text{ k}\Omega}$

and $\frac{3I_2}{I_2} = \frac{R}{2.2\text{ k}\Omega} \Rightarrow R = 3(2.2\text{ k}\Omega) = \mathbf{6.6\text{ k}\Omega}$

28. $I_{8\Omega} = \frac{12\text{ V}}{8\ \Omega} = 1.5\text{ A},\ I_{56\Omega} = \frac{12\text{ V}}{56\ \Omega} = 0.214\text{ A}$

$I_2 = I_{8\Omega} + I_{56\Omega} = 1.5\text{ A} + 0.214\text{ A} = \mathbf{1.714\text{ A}}$

$I_1 = \frac{I_2}{2} = \mathbf{0.857\text{ A}}$

30. a. $I_s = \frac{E}{R_T} = \frac{12\text{ V}}{0.1\text{ k}\Omega + 10\text{ k}\Omega} = \frac{12\text{ V}}{10.1\text{ k}\Omega} = \mathbf{1.188\text{ mA}}$

$V_L = I_sR_L = (1.188\text{ mA})(10\text{ k}\Omega) = \mathbf{11.88\text{ V}}$

b. $I_s = \frac{12\text{ V}}{100\ \Omega} = \mathbf{120\text{ mA}}$

c. $V_L = E = \mathbf{12\text{ V}}$

32. a. $I_1 = \frac{20\text{ V}}{4\ \Omega} = \mathbf{5\text{ A}},\ I_2 = \mathbf{0\text{ A}}$

b. $V_1 = \mathbf{0\text{ V}},\ V_2 = \mathbf{20\text{ V}}$

c. $I_s = I_1 = \mathbf{5\text{ A}}$

34. Not operating properly!

6 kΩ resistor not part of configuration (open at one or both terminals)

$R_T = \frac{6\text{ V}}{3.5\text{ mA}} = 1.714\text{ k}\Omega$

$R_T = 3\text{ k}\Omega \parallel 4\text{ k}\Omega = 1.714\text{ k}\Omega$

36. a. Connection at either end or 1 kΩ resistor opened up.

b. −4 V source connected as +4 V